Nuclear Gauge, Embankment/Surfacing/ Pavement Application

Construction Inspector's Training Manual

January 2006

Washington State
Department of Transportation

Nuclear Gauge,
Embankment/Surfacing/
Pavement Application

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Contents

Part 1
Earthwork and Surfacing Compaction Requirements

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Introduction

The Nuclear Density testing course helps prepare the participant to work safely on the roadway and to perform the duties of an inspector and tester for Nuclear Density testing.

The specific goals of this course are:

- Provide the tester with the skills needed to test Nuclear Densities on Embankment/Surfacing and Hot-Mix Asphalt for compliance to the Standard Specifications.
- Provide the Nuclear Density tester with the initial skills to perform:
    - **WSDOT FOP for AASHTO T-310**
    - **WSDOT FOP for AASHTO T-224**
    - **WSDOT TM 606 ***
    - **WSDOT SOP 615**
    - **WSDOT FOP for AASHTO T-99/272 ***
    - **WSDOT FOP for WAQTC TM 8**
    - **WSDOT TM 716**

* Lab test results used for maximum density comparison.

Objectives

Upon leaving this course you will be able to:

- List four safety factors while working on a roadway.
- Demonstrate two density testing procedures.
- Calculate an embankment/surfacing density.
- Calculate a Hot-Mix Asphalt pavement density.
- Interpret the difference between Granular and Non-Granular material.

Definitions

Angle of Repose — The angle between the horizontal and the maximum slope that a soil assumes through natural processes. For dry granular soils, the effect of the height of slope is negligible; for cohesive soils, the effect of height of slope is so great that the angle of repose is meaningless.

Borrow — Borrow is the excavation of material outside the roadway prism including its use in building embankments, subgrade, shoulders, and other highway components.

Boulders — A rock fragment, usually rounded by weathering or abrasion, with an average diameter of 12 inches or more.

Bridge Approach Embankments — An embankment beneath a structure and extending 12 inches beyond a structure's end (at subgrade elevation for the full embankment width) plus an access ramp on a 1:10 slope to the original ground elevation. Also, any embankment that replaces unsuitable foundation soil beneath the bridge approach embankment.

Bulking — The increase in volume of a material due to manipulation. Rock bulks upon being excavated; damp sand bulks if loosely deposited, as by dumping, because the apparent cohesion prevents movement of the soil particles to form a reduced volume.

Caliche — Soil material which consists of layers of weathered deposits bonded by carbonates, such as lime.

Clay (Clay Soil) — Fine-grained soil or the fine-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. The term has been used to designate the percentage finer than 0.002 mm (0.005 mm in some cases), but it is strongly recommended that this usage be discontinued, since there is ample evidence from an engineering standpoint that the properties described in the above definition are many times more important.

Clay Size — That portion of the soil finer than 0.002 mm (0.005 mm in some cases).

Cobble — A rock fragment, usually rounded or semirounded, with an average dimension between 3 to 12 inches.

Cohesionless Soil — A soil that when unconfined has little or no strength when air-dried and that has little or no cohesion when submerged.

Cohesive Soil — A soil that when unconfined has considerable strength when air-dried and that has significant cohesion when submerged.

Compaction — The densification of a soil by means of mechanical manipulation.

Compaction Test (Moisture-Density Test) — A laboratory compacting procedure whereby a soil at a known water content is placed in a specified manner into mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting unit weight determined. The procedure is repeated for various water contents sufficient to establish a relation between water content and unit weight.

Compression — A volume change produced by application of a static external load.

Consolidation — A volume change that is achieved naturally with the passage of time.

Contractor — The individual, partnership, firm, corporation, or joint venture, contracting with the state to do prescribed work.

Density — The weight of solids per unit volume. Dry density is calculated by dividing the weight of the solids by the volume of solids, water and air.

Earth Embankment — Any material other than that used in rock embankment.

End Product Specification — A specification in which acceptance of the work is based on the finished product. This kind of specification allows the contractor to choose whatever method he chooses to achieve that end product. (See also "Method Specification.")

Engineer — The Secretary of Transportation, acting directly or through his authorized representatives.

Fill — Man-made deposits of natural soils or rock products and waste materials.

Fines — Portion of a soil finer than a No. 200 standard sieve.

Frost Heave — The raising of a surface due to the accumulation of ice in the underlying soil or rock.

Glacial Till (Till) — Material deposited by a process know as glaciation, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water.

Granular material — Are soil particles which do not have internal cohesive forces, but rather get their strength from friction.

Gravel — is rounded or semi-rounded particles of rock that will pass a 3 inch and be retained on a No. 4 standard sieve.

Gumbo — A material identified by a soapy or waxy appearance when wet.

Hardpan — A hard impervious layer, composed chiefly of clay, cemented by relatively insoluble materials, that does not become plastic when mixed with water and definitely limits the downward movement of water and roots.

Highway — A public way for vehicles, including the entire right of way.

Humus — A brown or black material formed by the partial decomposition of vegetable or animal matter; the organic portion of soil.

Inspector — The project engineer's representative who inspects contract performance in detail.

Loam — A mixture of sand, silt, or clay, or a combination of any of these, with organic matter (see humus). It is sometimes called topsoil in contrast to the topsoil's that contain little or no organic matter. Loam is cohesive.

Loess — A uniform Aeolian deposit of silty material having an open structure and relatively high cohesion due to cementation of clay or calcareous material al grain contacts. A characteristic of loess deposits is that they can stand with nearly vertical slopes.

Method Specification — A specification in which the manner in which the work is to be performed is specified. An example is the specification for compaction of rock embankments. This kind of specification implies that acceptance of the work will be based on how the work is performed regardless of what the end product is(See also "End Product Specification.").

Moisture Content (Water Content) — The ratio, expressed as a percentage, of: (1) the weight of water in a given soil mass, to (2) the weight of solid particles.

Muck — Stone, dirt, debris, or useless material, or an organic soil of very soft consistency.

Optimum Moisture — The exact amount of water necessary to coat and lubricate each soil particle so the maximum density for any compaction effect may be obtained.

Organic Soil — Soil with a high organic content. In general, organic soils are very compressible and have poor load-sustaining properties.

Peat — A fibrous mass of organic matter in various stages of decomposition, generally dark brown to black in color and of spongy consistency.

Percent Compaction — This is the ratio of the actual in-place dry density of a soil to the maximum theoretical dry density.

Plasticity — The property of a soil or rock which allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.

Project Engineer — The engineer's representative who directly supervises the engineering and administration of a construction project.

Roadbed — The graded part of a highway within top and side slopes that forms a foundation for the pavement structure and shoulders (WSDOT *Standard Specification* 1-01.21).

Roadway — Any construction work within the right of way.

Rock — Natural solid mineral matter occurring in large masses or fragments.

Rock Embankment — An embankment in which all or any part of the embankment contains 25 percent or more, by volume, gravel or stone 4 inches or more in diameter.

Sand — Particles of rock that will pass the No. 4 sieve and be retained on the No. 200 U.S. standard sieves.

Shoulder — The part of the roadway next to the traveled way. It provides lateral support of base and surface courses and is an emergency stopping area for vehicles.

Silt (Rock Flour) — Material passing the No. 200 standard sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when air dried.

Silt Size — That portion of the soil finer than 0.02 mm and coarser than 0.002 mm (0.05 mm and 0.005 mm in some cases).

Sluicing — A method of excavation by which material is moved by flushing with water.

Soil (Earth) — Sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter.

Soil Binder — That portion of soil passing the No. 40 sieve.

Stone — Crushed or naturally angular particles of rock that will pass a 3-inch sieve and be retained on a No. 4 sieve.

Structures — Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, service pipes, sewers, underdrains, foundation drains, and other features found during work that the contract may or may not classify as a structure.

Subcontractor — An individual, partnership, firm, corporation, or joint venture who is sublet part of the contract by the contractor.

Subgrade — That part of the roadbed on which subgrade, base, surfacing, pavement, or layers of similar materials are placed.
Talus — Rock fragments mixed with soil at the foot of a natural slope from which they have been separated.

Topsoil — Surface soil, usually containing organic matter.

Traveled Way — The part of the road made for vehicle travel excluding shoulders and auxiliary lanes.
No. 4 Sieve — This is the sieve used to calculate the "percent passing the No. 4sieve" for use with a maximum density curve, and to calculate the "percent retained on the No. 4 sieve" for use with the Nomograph curve. A U.S. Standard No. 4 sieve is **not** the same as a 1/4 inch sieve.

U.S. Standard No. 4	=	.187 inches opening
U.S. Standard 1/4 inch	=	.250 inches opening.

Safety

Safety is one of the most important aspects of all in construction inspection, but sadly it is too often neglected. Compaction inspection in particular has many hazards about which the inspector should constantly be aware. Some general rules to remember are as follows:

- Always wear a hard hat and vest. This is important regardless of whether or not the inspection is being done near the traveling public. A hard hat and vest help the power-equipment operators see you better.

- Always assume that power-equipment operators **do not** see you. A backhoe operator digging a trench is watching the bucket, a belly-dump driver is looking in his rearview mirror when spreading surfacing.

- Never park or stand behind a piece of heavy equipment which is parked. If the operator does not walk around behind his rig before he takes off, he will probably back over you.

- Before driving or walking through an earthwork project, find out which direction the equipment is hauling; either ask someone who knows, or watch long enough to figure it out for yourself. Coming to a near head-on collision with a loaded scraper on a narrow haul road is not only dangerous, but it could be fatal.

- When watching a backhoe in operation, stay completely out of his reach, on both sides of a trench.

- Finally, use common sense. It is the best protection you have got.

Density Inspection

As a field density inspector your duties are not only verifying compaction of the earthwork but may also include part or all of the following:

- Obtain samples and complete transmittals for native materials, manufactured materials as well as pit run materials.
- Monitor lift thickness that may vary due to type of material or location within the roadway prism.
- Verify density and moisture content of each lift.
- Define and correct unsuitable foundations, un-compacted areas and areas of pumping sub-grade.
- Monitor cut sections for change in material changes in material types will require new density curves.
- Inspect slope construction for proper slope and that the slope was track walked.
- Check routing of haul equipment the haul equipment should split wheel tracks.

Equipment

Nuclear Density/Moisture Gauge, Scales, (2) 5 gallon plastic buckets, Propane Burner or Methanol for drying, Two Pans, 12" x 18" or larger, Density Reports of the material to be tested, shovel, trowel, scoop, Forms-Field Density Test, Daily Compaction Test Report and a No. 4 Sieve.

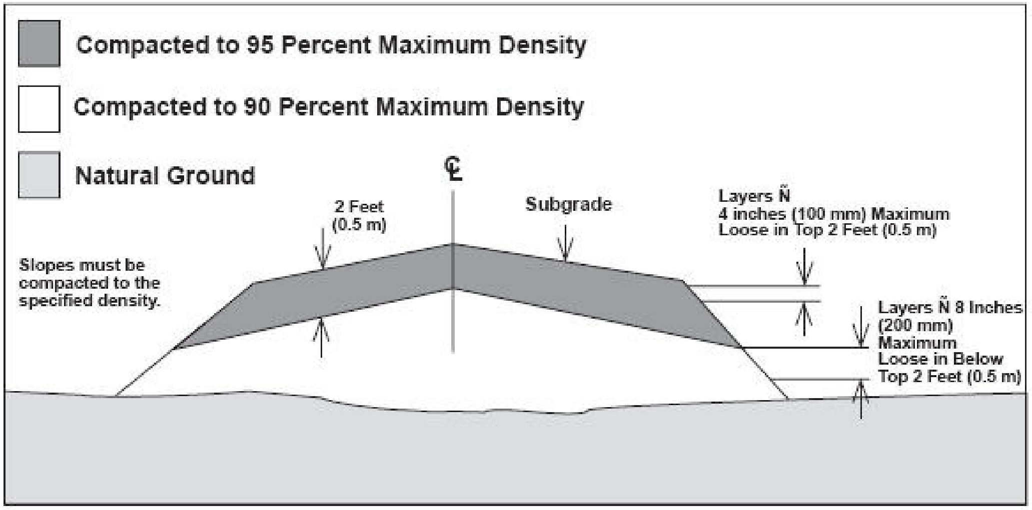
Embankment Types

There are two types of embankment, earth embankment and rock embankment. Rock Embankment is defined as having 25 percent or more by volume of material greater than 4 inches in diameter.

Any material with less than 25 percent is considered earth embankment. It is important that you know what type of embankment material is being placed. Each type has a different compaction requirement based on type of material and location of the material being placed.

Earth Embankment: Method B Compaction

Standard Specification 2-03.3(14)C



Item	Required	Std. Spec. Ref.
Application	Method B Compaction is always used unless the Special Provisions require another method.	2-03.3(14)C
Compaction	95 percent — top 2 feet 90 percent — below top 2 feet	2-03.3(14)C
Moisture	Less than 3 percent above optimum for material passing U.S. No. 4 sieve.*	2-03.3(14)C
Lift Thickness	2 feet - 4 inches max. loose. Below top 2 feet - 8 inches max. loose.**	2-03.3(14)C
Allowable Compaction Equipment	Any equipment approved by the engineer.	2-03.3(14)C
Test Frequency	One density and one moisture every 2,500 CY.	9-5.7 (*Const. Manual*)

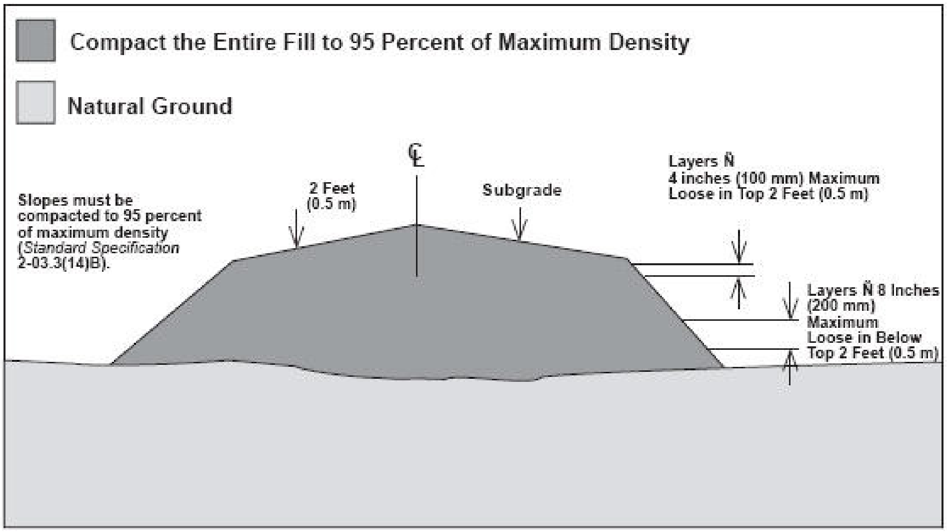
Other references: *Standard Specification* 2-03.3(14)B, *Construction Manual* 2-3.2A, *Construction Manual* 2-3.2C, *Construction Manual* 9-3.1H, WSDOT FOP for AASHTO T-310 .

* The engineer may permit higher moisture. See *Standard Specification* 2-03.3(14)C for conditions.

** The engineer may permit thicker layers. See *Standard Specification* 2-03.3(14)C for conditions.

Earth Embankment: Method C Compaction

Standard Specification 2-03.3(14)C



Item	**Required**	**Std. Spec. Ref.**
Application	Method C Compaction is used only when specified.	2-03.3(14)C
Compaction	95 percent each layer.	
Moisture	Less than 3 percent above or below optimum for material passing No. 4 sieve.*	2-3.3(14)C
Lift Thickness	Top 2 feet - 4 inches max. loose. Below top 2 feet - 8 inches max. loose.**	2-03.3(14)C
Allowable	Any equipment approved by the engineer Compaction may be used. Equipment	2-03.3(14)C
Test Frequency	One density and one moisture every 2,500 CY.	9-5.7 (*Construction Manual*)

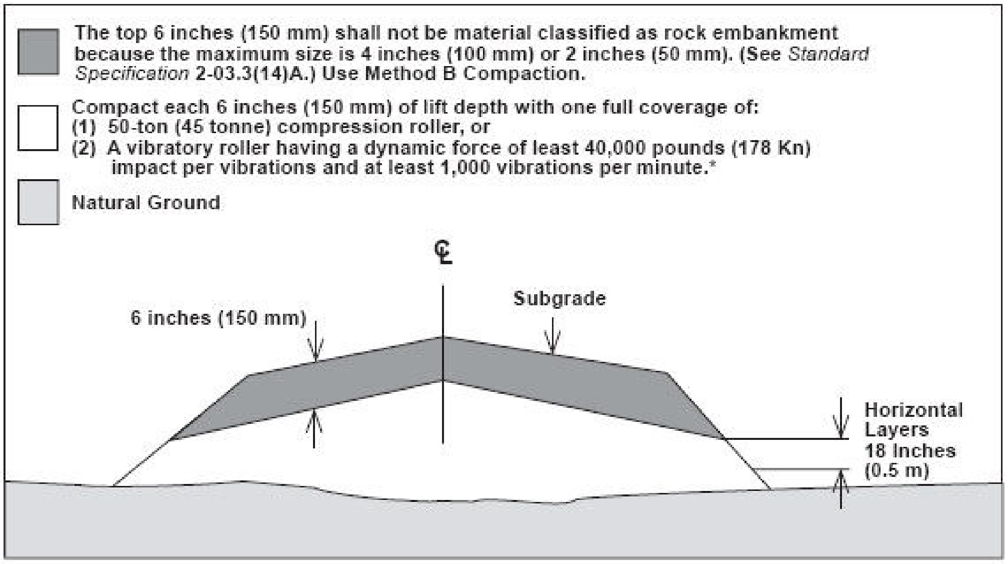
Other references: *Standard Specification* 2-03.3(14)B, *Standard Specification* 2-03.3(14)D, *Construction Manual* 2-3.2A, *Construction Manual* 2-3.2C, FOP for AASHTO T-310.

* The engineer may permit higher moisture. See *Standard Specification* 2-03.3(14)C for conditions.

** The engineer may permit thicker layers. See *Standard Specification* 2-03.3(14)C for conditions.

Rock Embankment

Standard Specification 2-03.3(14)A



Requirements

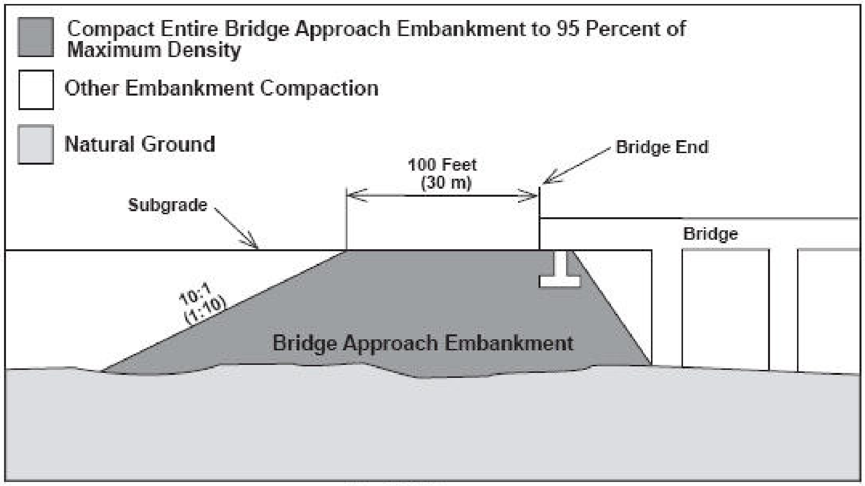
Item	Required	Std. Spec. Ref.
Application	Any embankment which is defined as "Rock Embankment" See *Standard Specification* 2-03.3(14) for definition.	
Compaction	Compact each 6 inches of lift depth, or fraction thereof, with roller as noted above. In addition to rolling, the empty and loaded hauling equipment shall be routed evenly over the width of embankment, if possible.	2-03.3(14)A
Roller Speed	4 mph maximum for compression rollers, 1.5 mph maximum for vibratory rollers.	2-03.3(14)A
Test Frequency	Visual inspection.	

Other references: *Construction Manual* 2-3.2A and *Construction Manual* 2-3.2B.

* If depth is 18 inches or less, contractor may compact each 6 inches of lift depth with four full coverages with: (1) 10-ton compression roller or (2) a vibratory roller having a dynamic force of at least 30,000 pounds per vibration and at least 1,000 vibrations per minute (*Standard Specification* 2-03.(14)A).

** If rocks average more than 18 inches in diameter, then layers may be as deep as required to allow their placement (*Standard Specification* 2-03.3(14)A).

Bridge Approach Embankments
Standard Specification 2-03.3(14)I



Profile View

Requirements

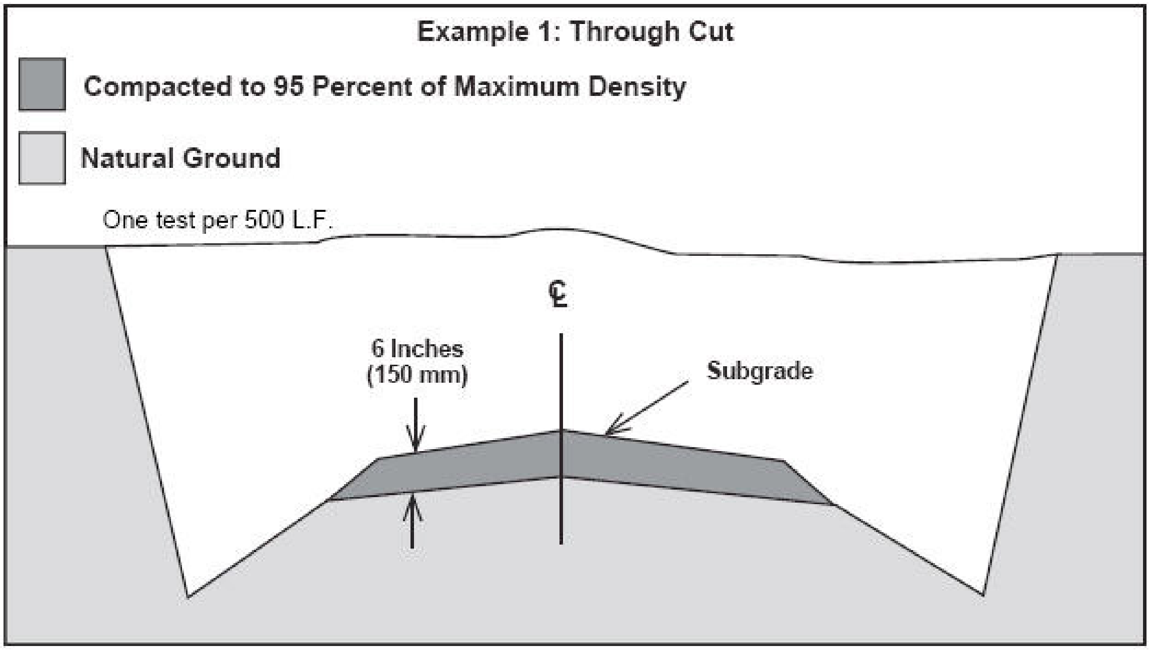
Item	Required	Std. Spec. Ref.
Application	Embankments at all bridge and trestle ends	2-03.3(14)1
Compaction	95 percent each layer	2-03.3(14)1
Moisture	Less than 3 percent above optimum for material passing No. 4 sieve*	2-03.3(14)C Method B
Lift Thickness	Top 2 feet - 4 inches max. loose Below top 2 feet - 8 inches max. loose**	2-03.3(14)C Method B
Allowable Compaction Equipment	Any equipment approved by the engineer may be used.	2-03.3(14)C
Frequency	One density and one moisture every 2,500 CY.	9-5.7 (*Construction Manual*)

Other references: *Standard Specification* 2-03.3(14)B, *Standard Specification* 2-03.3(14)D, *Standard Specification* 1-01.3, *Standard Plan* H-9, *Construction Manual* 2-3.2A, *Construction Manual* 2-3.2C, *Construction Manual* 9-3.1H, FOP for AASHTO T-310.

* The engineer may permit higher moisture. See *Standard Specification* 2-03.3(14)C for conditions.

** The engineer may permit thicker layers. See *Standard Specification* 2-03.3(14)C for conditions.

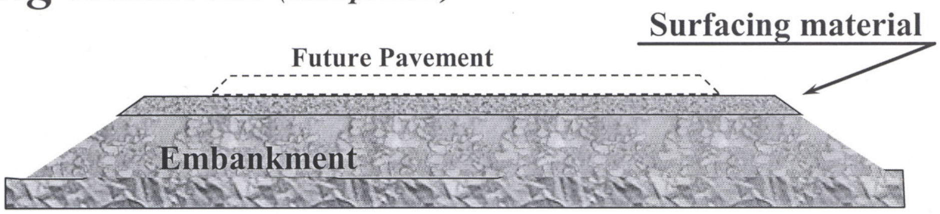
Subgrade for Surfacing
Standard Specification 2-06.3(1)

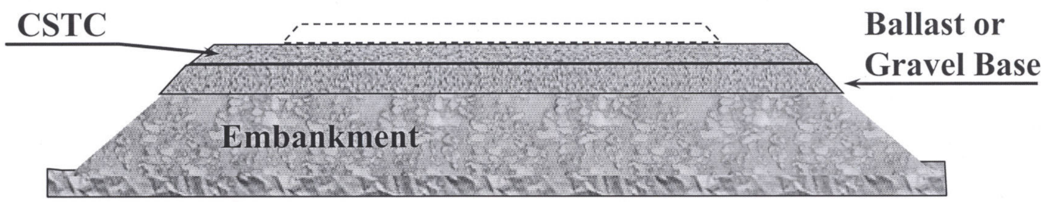


Compact the top 6” to 95% Maximum Density.

One test every 500 L.F.

Surfacing Material *(Except ATB)*





Compaction: 95% each layer
Lift Thickness: Ballast = 0.5'
Crushed Surfacing = 0.35'
Gravel Base = 0.75'
Test Frequency: 1 Density each layer every 1000LF

Item	**Required**	**Std. Spec. Ref.**
Compaction	95 percent each layer	4-04.3(5)
Lift Thickness	CSBC, CSTC — 0.35 feet max. compacted	4-04.3(4)
	Ballast — 0.50 feet max. compacted	4-04.3(4)
	Gravel Base — 0.75 feet max. compacted	4-04.3(4)
Test Frequency	One density each layer every 1,000 LF	9-5.7 (*Construction Manual*)

Other references: *Standard Specification* 4-04.3(7), *Standard Specification* 4-04.3(8), *Construction Manual* Chapter 4, WSDOT FOP for AASHTO T-310.

* No surfacing materials shall be placed in snow or on a soft, muddy, or frozen sub-grade. See *Standard Specification* 4-04.3(8)).

** Density testing may not be required by engineer. See *Standard Specification* 4-04.3(5) for conditions

Part 2
Earthwork and Granular Compaction Tests

Part 2 Earthwork and Granular Compaction Tests

Test Procedures

To perform in-place density using nuclear methods for granular and non-granular material, the following test procedures will be required:

- **WSDOT FOP for AASHTO T 310**
  In place Density and Moisture Content of Soil
- **WSDOT SOP Number 615**
  In Place Density of Embankment and Base
- **WSDOT FOP for AASHTO T 224**
  Correction for Coarse Particles
- **WSDOT FOP for AASHTO T 272**
  Family of Curves – One Point Method
- **WSDOT FOP for Test Method AASHTO T 99**
  Moisture Density Relations of Soils
- **WSDOT TM 606**
  Maximum Density Curve
- **WSDOT FOP for Test Method AASHTO T 180**
  Moisture Density Relations of Soils

Specific Gravity

The relationship between the weight of an object and the weight of water of equal volume.

Compaction

Every soil has an **optimum moisture content** at which it reaches a **maximum density** for a given compactive effort.

Density

The percentage of maximum density is determined by the dry density from the average gauge readings divided by the dry density from the appropriate density curve multiplied by 100.

Soil Types

Granular Soil - Soil with 30 percent or more material retained on the No. 4 sieve, use maximum density curve.

Non-granular Soil - All soils with **less than** 30 percent material retained on the No. 4 sieve

Control of Compaction of Granular Material

Use of the Maximum Density Curve Maximum Density Curve

To acquire a maximum density curve the engineer's office needs to submit a sample of the granular material from the contractor's approved source. Be aware that it may take up to five working days to obtain a "Maximum Density Curve."

The sample must meet the gradation requirements for material being submitted and be between 100 to 150 pounds.

At the Regional Materials Lab the sample is dried, graded and divided into two fractions separated on the No. 4 sieve. Compaction tests and specific gravity test are performed on the two fractions and from that data the "Maximum Density versus Percent passing No. 4 sieve " curve is drawn. This curve, known as the "Maximum Density Curve is submitted to the project field office and is used for density control reference.

A "Maximum Density Curve" is unique to each sample submitted. The field density inspector must use the proper curve for the material being tested.

Compaction Test for Granular Material

This test procedure and standard operating procedure are applicable to crushed surfacing, ballast, gravel base, granular aggregates and non-plastic fines. When coarser aggregates are encountered, the oversize material must be avoided during the field test or corrected for on a straight volume weight correction basis.

Washington State Department of Transportation

Maximum Density Curve

Barcode Number: 0000319388

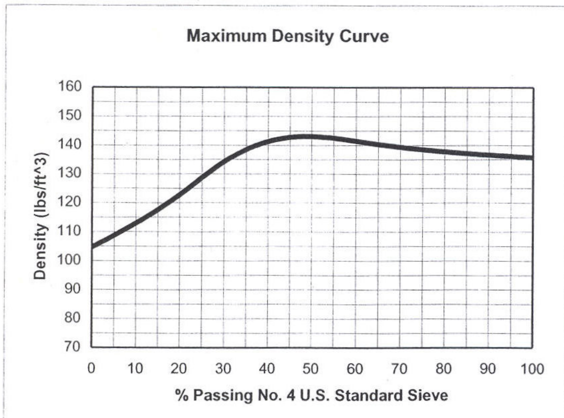
Lab ID Number: D1-006-05

Sample Identification Data	
Contract Number:	6611
SR #:	018
Pit Number:	A-477
Section:	Maple Valley To Issaquah/Hobart Rd.
Material Description:	CSBC
Project Engineer:	Derek Case
Date Received:	2/24/2005

Input Data	
Coarse Density (lbs/ft^3):	104.6
Fine Density (lbs/ft^3):	135.7
Coarse Specifi Gravity:	2.75
Fine Specific Gravity:	2.72

Results	
Passing #4 @ Maximum Density:	49.0
Maximum Density (lbs/ft^3):	**143.0**
Passing #4 @ Minimum Density:	0.0
Minimum Density (lbs/ft^3):	104.6
Percent Passing #4:	26.8
Approx. Opt. Moisture #4-0:	8.0
Corrected Optimum Moisture:	2.2

Corrected Optimum Moisture = (Approx. Opt. Moisture #4-0 X Percent Passing #4)/100



T Codes: T-633

Approved By: JA Date: 3-2-05

Density Curves			
Pass #4	Maximum	Pass #4	Maximum
0.0	104.6	51.0	143.0
1.0	105.4	52.0	142.9
2.0	106.2	53.0	142.8
3.0	107.0	54.0	142.6
4.0	107.8	55.0	142.5
5.0	108.7	56.0	142.3
6.0	109.5	57.0	142.1
7.0	110.3	58.0	141.9
8.0	111.2	59.0	141.7
9.0	112.0	60.0	141.4
10.0	112.9	61.0	141.2
11.0	113.8	62.0	141.0
12.0	114.7	63.0	140.8
13.0	115.6	64.0	140.5
14.0	116.6	65.0	140.3
15.0	117.5	66.0	140.1
16.0	118.5	67.0	139.9
17.0	119.5	68.0	139.7
18.0	120.6	69.0	139.5
19.0	121.6	70.0	139.3
20.0	122.7	71.0	139.1
21.0	123.9	72.0	139.0
22.0	125.0	73.0	138.8
23.0	126.2	74.0	138.6
24.0	127.4	75.0	138.5
25.0	128.6	76.0	138.3
26.0	129.8	77.0	138.2
27.0	131.0	78.0	138.0
28.0	132.1	79.0	137.9
29.0	133.2	80.0	137.8
30.0	134.2	81.0	137.7
31.0	135.2	82.0	137.5
32.0	136.1	83.0	137.4
33.0	136.9	84.0	137.3
34.0	137.7	85.0	137.2
35.0	138.4	86.0	137.1
36.0	139.1	87.0	137.0
37.0	139.7	88.0	136.8
38.0	140.3	89.0	136.7
39.0	140.8	90.0	136.6
40.0	141.2	91.0	136.5
41.0	141.6	92.0	136.4
42.0	142.0	93.0	136.3
43.0	142.3	94.0	136.3
44.0	142.5	95.0	136.2
45.0	142.7	96.0	136.1
46.0	142.9	97.0	136.0
47.0	143.0	98.0	135.9
48.0	143.0	99.0	135.8
49.0	143.0	100.0	135.7
50.0	143.0		

MS Excel Version 2.1 - March 2004

2/28/2005

Washington State Department of Transportation

Field Density Test

Contract Number 6611 SR Number 18 Date 9/28/2005

Section Maple Valley to Issaquah/Hobart Rd. I/C Inspector Dirk Diggler

*** Test Hole Number**		BC-75		BC-76
Station to Station				
* Test Station		EB 1486+00		EB1495+55
* Reference to Center Line		5' Rt.		8' Lt.
* Reference to Subgrade		+0.35		+0.35
* Material (Clay, Top Course, etc.)		CSBC		CSBC
Depth of Material (If surfacing)		0.35'		0.35'
Gauge Readings				
Dry Density lbs/cu ft	0	136.3		137.4
	90	135.2		134.7
*Average Dry Density lbs/cu ft	Average	135.8		136.1
Moisture Content	0	10.2		9.8
	90	9.5		10.3
* Average Moisture Content	Average	9.9		10.1
Gradation Determination				
Mass of Sample (Dry or SSD) + Tare		11.43		11.52
Mass of Tare A		2.10		2.10
Mass of Sample (Dry or SSD) = [Mass of Sample - TareA]		9.33		
Mass Retained on No. 4 Sieve + Tare		7.23		6.81
Mass of Tare B		2.10		2.10
Mass of Material Retained on No. 4 Sieve = [Mass Retained - TareB]		5.13		
% Retained on No. 4 Sieve (% Oversize) = Mass Retained / Mass of Sample (100)		55		
* % Pass No. 4 Sieve = (100 - Percent Retained)		45		
Specification Density Determination				
* Maximum Density from appropriate curve lbs/cu ft		142.7		
* Standard (Curve or Lab ID Number)		D1-006-05		D1-006-05
* Corrected Maximum Density for Oversize, lbs./cu ft (for non-granular material only)				
* Density lbs/cu ft (% of maximum) = Dry Density (100) / Maximum Density		95		
Optimum Moisture Determination				
* Optimum Moisture (from curve)				
* Opt. Moisture Corrected (non-granular mat. only) = Opt. Moisture X % Passing No. 4 / 100				

Comments

Note: If retest, add letter to number such as 1st test No. 27, retest 27A

*** Information is to be transferred to DOT Form 351-015, "Daily Compaction Test Report"**

DOT Form 350-074 EF
5/02

Washington State Department of Transportation

MOISTURE - DENSITY RELATIONSHIP REPORT

FIELD SAMPLE NO. 0000335477 LAB NO. 01-089-05

CONT. NO. 6611 F.A. NO. ______ S.R. NO. ______

SECTION Maple Valley to Issaquah/Hobart Rd. I/C SOURCE OF MAT'LS ______

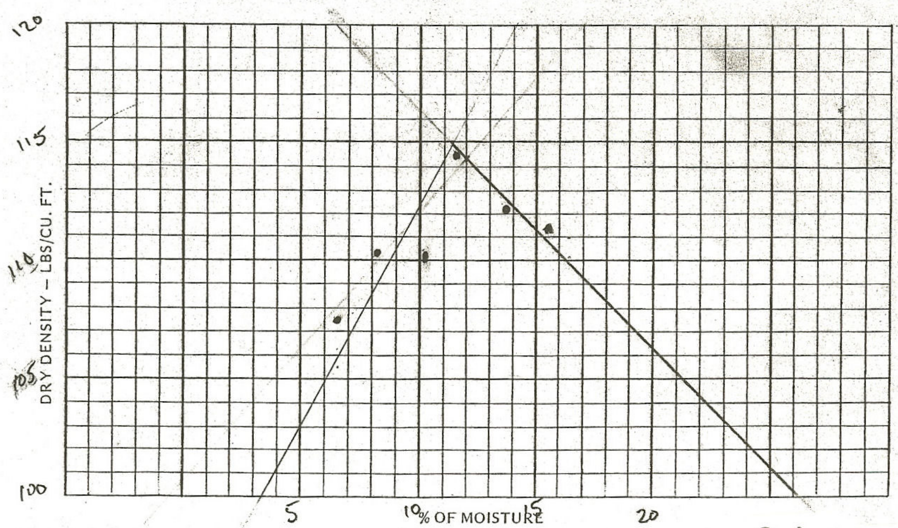
TYPE OF MATERIAL Native

PERCENT PASSING NO. 4 85.5 DATE TAKEN 9-8-05 DATE TESTED 9-12-05

STATION ______ REFERENCE TO C/L ______ REFERENCE TO GRADE ______

Can No.	1	2	3	4	5	6				
Specimen Wt. + Cyl.	3824.2	3891.4	3925.4	4023.5	4016.9	4038.8				
Cyl. Wt.	2091.0	2091.0	2091.0	2091.0	2091.0	2091.0				
Specimen Wt. (Grams)	1733.2	1800.4	1834.4	1932.5	1925.9	1947.8				
Specimen Wt. (lbs.)	3.82	3.97	4.04	4.26	4.25	4.29				
Vol. of Cyl.	0.03333	.03333	.03333	.03333	.03333	.03333				
Wet Density	114.6	119.1	121.2	127.8	127.5	128.7				
Wet Sample + Can	324.6	323.3	338.7	366.6	307.6	304.2				
Dry Sample + Can	316.3	313.3	328.2	350.8	293.4	289.2				
Wt. of Moisture	8.3	10.0	10.5	15.8	14.2	15.0				
Wt. of Can	190.1	188.7	225.1	214.8	189.7	192.8				
Wt. of Dry Soil	126.2	124.6	103.1	136.0	103.7	96.4				
% Moisture	6.577	8.026	10.184	11.618	13.693	15.560				
Dry Density	107.5	110.3	110.0	114.5	112.1	111.4				
Speedy Grams / Gauge										
Speedy Grams / % Moisture										
Speedy Dry Density										

NOTE: OVEN DRY & SPEEDY TO BE USED FOR CORRELATION ON TYPICAL MATERIALS



OPT. MOIST. 11.4%

MAX. DENSITY 114.9

BY Brian Meoff

DATE 9-12-05

DOT FORM 350-514 REVISED 4/86

Moisture — Density Relationship Curve

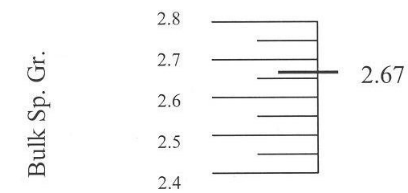
A 100 to 150 pound sample of clean granular soils and soils with less than 70 percent or more passing the No. 4 sieve must be submitted to the Regional Materials Laboratory with a request for a maximum density curve. It may take up to five working days to perform the testing and return to the project office a moisture density relationship curve.

Each "Moisture-Density Relationship Curve" is unique to the material being submitted. It is important that the field density inspector use the proper curve for the material being tested.

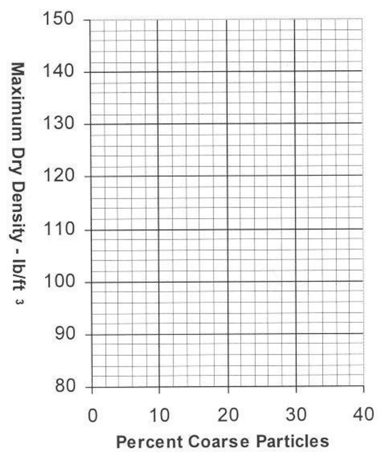
Correction for Oversize Using Nomograph (Pg 2-9)

The test procedure is performed per WSDOT FOP for AASHTO T 310, and an in-place density performed by SOP T 224. When using the "Moisture Density Relationship Curve" a correction for oversize may be required. The correction for oversize material is performed using Standard Operating Procedure WSDOT (SOP) 615, WSDOT FOP for AASHTO T 224 and WSDOT FOP for AASHTO T-99, Method "A."or WSDOT FOP for AASHTO T180,Method "D." Oversize is defined as material that is retained on the No. 4 sieve for WSDOT FOP for AASHTO T-99 AND THE 3/4 sieve for WSDOT FOP for AASHTO T-180.

To convert from density of fines to density of fines plus oversize, follow the instructions given in T 224. (This form will be handed out to you by your instructor).



If the specific gravity us unknown, then use 2.67



Washington State Department of Transportation

Field Density Test

Contract Number 6611 SR Number 18 Date 9/28/2005

Section Maple Valley to Issaquah/Hobart Rd. I/C Inspector Dirk Diggler

* Test Hole Number		SG-45		SG-45A
Station to Station				
* Test Station		1490+15		1490+15
* Reference to Center Line		9' Rt.		9' Rt.
* Reference to Subgrade		-1.5'		-1.5'
* Material (Clay, Top Course, etc.)		Native		Native
Depth of Material (If surfacing)		-		-
Gauge Readings				
Dry Density lbs/cu ft	0	108.2		111.3
	90	111.2		113.0
*Average Dry Density lbs/cu ft	Average	109.7		112.2
Moisture Content	0	9.5		10.1
	90	9.0		10.3
* Average Moisture Content	Average	9.3		10.2
Gradation Determination				
Mass of Sample (Dry or SSD) + Tare		11.76		11.27
Mass of Tare A		2.10		2.10
Mass of Sample (Dry or SSD) = [Mass of Sample - TareA]		9.66		
Mass Retained on No. 4 Sieve + Tare		4.03		3.13
Mass of Tare B		2.10		2.10
Mass of Material Retained on No. 4 Sieve = [Mass Retained - TareB]		1.93		
% Retained on No. 4 Sieve (% Oversize) =	Mass Retained / Mass of Sample (100)	20		
* % Pass No. 4 Sieve = (100 - Percent Retained)		80		
Specification Density Determination				
* Maximum Density from appropriate curve lbs/cu ft		114.9		114.9
* Standard (Curve or Lab ID Number)		D1-089-05		D1-089-05
* Corrected Maximum Density for Oversize, lbs./cu ft (for non-granular material only)		122.0		
* Density lbs/cu ft (% of maximum) =	Dry Density (100) / Maximum Density	90		
Optimum Moisture Determination				
* Optimum Moisture (from curve)		11.4		
* Opt. Moisture Corrected (non-granular mat. only) = Opt. Moisture X % Passing No. 4 / 100		9.1		

Comments

Note: If retest, add letter to number such as 1st test No. 27, retest 27A

*** Information is to be transferred to DOT Form 351-015, "Daily Compaction Test Report"**

DOT Form 350-074 EF
5/02

Family of Curves-One Point Method

This test is similar to AASHTO T-272 and is performed in order to provide the engineer with a rapid determination of the maximum density and optimum moisture content of a soil sample utilizing a family of curves and a one point determination. This method may be used as a standard for controlling compaction of fine grained soils.

A family of curves is a group of typical soil-moisture-density relationships determined using AASHTO T-99 or WSDOT FOP for AASHTO T-99. These soil-moisture-density relationships or curves reveal certain similarities and trends characteristics of the soil type and source. Soils sampled from one source will have many different moisture-density curves, but when a group of these are plotted together certain relationships usually become apparent. In general it will be found that higher unit mass soils assume steeper slopes with maximum dry densities at lower optimum moisture contents, while lower unit mass soils assume flatter more gently sloped curves with higher optimum moisture contents.

The purpose of the family of curves is to represent the average moisture-density characteristics of the material. The family must, therefore be based on moisture-density relationships which adequately represent the entire mass range and all types of material for which the family is to be used. It may be that particular soil types have a moisture-density relationship that differ considerably and cannot be represented on one general family of curves: in this case a separate family may be developed.

When a small number of moisture-density relationships are being used to develop a family of curves, plot the point representing the maximum density and optimum moisture content for each relationship on a single piece of graph paper. Draw a smooth curve which as closely as possible connects all these points. This line will define the maximum density and optimum moisture content of the material represented by this family of curves.

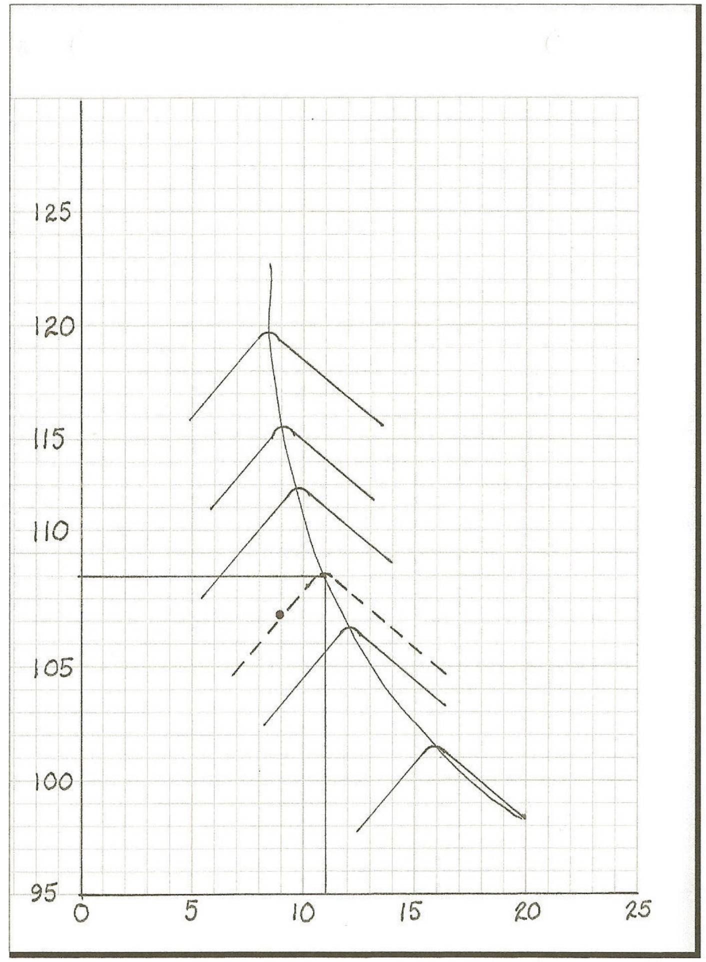
First plot previous moisture density relationship curves.

Next do your one-shot proctor.

Mark the location of your one-shot proctor on the graph.

Next plot a curve that best matches the closest curve from your family of curves.

The peak of your curve is the interpolated maximum density & optimum moisture for the material you have tested.



Daily Compaction Test Report

Correction for oversize is only applied when using a Proctor Curve since the Proctor is established on the fines.

Remember that the backfill of structure excavation has different requirements for different items in different locations. Refer to standard plans, standard specifications, and contract special provisions.

The form requires you to determine and indicate if the test is satisfactory or a failure. All failing tests should be noted in the remarks section with the corrective action taken. Note reasons for failure corrective action. Failing tests within 1 percent of the minimum requirements may be marked as Sat. or satisfactory provided that additional compactive effort is applied and so noted in the remarks. Remember that specifications have limitations on moisture percentage also and these should be checked for compliance.

The lower section of the form provides information that is just as valuable as the test data in the top section. Lift thickness, compaction equipment, and the number of coverages per lift are entered for each test or group of tests. Daily quantities are very important and can be entered for each test, group of tests, or for the day. The accumulative total is for embankment to date, backfill to date, top course to date, etc.

The number of tests required to date is determined from the *Construction Manual*. A quick comparison of the test number and this number shows you where you are compared to the requirement.

The bottom line is for rock embankments. There are no density tests for rock embankments, so test numbers are not appropriate.

The form should be completed daily for rock embankment construction by completing the heading, station, reference to centerline and sub-grade, type of material and use, and method of compaction in the top section of the form and the bottom line in the lower section of the form. The number of density tests required to date is not appropriate. Rock embankment compaction requirements are shown in Section 2-03.3(14)A and involve a number of coverages based on the weight of the compaction equipment and the lift thickness. All this information is listed on this line.

Please note that there are special requirements for the top 6 inches of rock embankments. These requirements are shown in Section 2-03.3(14)A. These requirements must be considered during the design of a project or early during construction. The requirements should be discussed with the contractor so that any problems can be solved early.

Occasionally, you will need a second page just to complete the lower section of the form. Complete the heading, including the page number, and then go right to the lower section of the form on page 2-15.

Washington State Department of Transportation

Daily Compaction Test Report

Project Engineer: Derek Case
Contractor: Atkinson / KLB
Project Name: Maple Valley to Issaquah/Hobart Rd. I/C

Contract Number: 6611
Date: 9-28-05
Page 1 of 1

Test No.	Sta. and Ref. to C/L	Ref. to Sub-grade	Type of Material and Use	Moisture Percent: Opt.	Moisture Percent: Opt. Corrected	Moisture Percent: Field Test	Percent Passing #4 Sieve	Dry Density PCF: Max.	Dry Density PCF: Corr.	Dry Density PCF: Std. No.	Dry Density PCF: Field Test	Dry Density PCF: % Max	Comp. Method/ % Min.	Check One: Sat.	Check One: Fail*
SG45	EB1490+15, 9'Rt.	-2.5'	Native	11.4	8.8	9.3	80	114.9	122.0	D100605	109.7	89.9	B		✓
SG45A	EB1490+15, 9'Rt.	-2.5'	Native	11.4	10.0	10.2	88	114.9	118.5	D100605	108.8	91.8	B	✓	
BC75	EB1486+00, 5'Rt.	+0.35'	CSBC	8.0	—	9.9	45	142.5	—	D108905	135.8	95.3	95	✓	
BC76	EB1495+55, 8'Lt.	+0.35'	CSBC	8.0	—	10.1	50	143.0	—	D108905	136.1	95.1	95	✓	

Optimum Moisture - Moisture content of No. 4 minus from Proctor curve.
Corrected Moisture - Optimum moisture corrected for oversize = Optimum Moisture Content x Percent Passing No. 4 Sieve.
Maximum Dry Density - Density from Proctor curve or Maximum Density for Granular Materials Curve.
Corrected Density - Proctor Maximum Dry Density Corrected for oversize.
Standard Number - Laboratory or identifying number of Density Standard used, i.e., Proctor No. or Maximum Density Curve.
Field Test - Moisture content or density of field sample tested.
Method of Compaction (specified): A, B, C, Rock Embankment (RO), Bridge Approach Embankment (BA).
** Note corrective action under Remarks.*

Summary of Compaction Quantities

Test Nos.	Lift Thick.	Compaction Equipment Used (Number, Weight, and Type of Units)	No. of Coverages Per Lift	Daily Quantities (C.Y. or Ton)	Accum. Total Quatities	No. of Density Tests Required To Date
SG45	8"	1-20 ton DDV	4	2500 CY	112,000 CY	45
BC 75	0.35'	1-20 ton DDV	6	2000 T	150,000 T	75
BC 76	0.35'	1-20 ton DDV	6	2000 T	152,000 T	76
Rock Emb.						

Remarks
Contractor added H_2O and re-rolled for test SG45A, Retest passed.

Distribution: Region Construction Engineer (If directed by Region)
Project Engineer
Region Materials Engineer

Dirk Diggler
Inspector

DOT Form 351-015 EF
Revised 9/02

Part 3
Pavement Applications

This workbook has been planned for use in conjunction with the Nuclear Gauge Operators Qualification Course, WSDOT Construction Manual and the WSDOT Standard Specifications.

This section contains practice problems which will provide the gauge operator with an understanding of the procedures for obtaining location of test sites and percent compaction of the hot mix asphalt. It will also provide practical experience in the required documentation involved in inspection and compaction testing requirements on hot mix asphalt placement.

The Asphalt Concrete Pavement (ACP) Density Testing, the following test procedures will be used:

WSDOT FOP for WAQTC TM 8
WSDOT Test Method 716
WSDOT SOP 729
WSDOT SOP 730

Duties

Along with the compaction testing of the ACP some of your other duties may include: doing the test section on the first day paving, marking out areas for correlation cores, verifying the roller pattern the contractor is using, checking finish depth of mat, watching for deficient areas in mat such as bleeding, reflective cracking or tearing of mat.

Inspection Tools

Nuclear Gauge, Stop Watch, drill rod, scraper plate, slide hammer, 4# to 8# maul, Thermometer, Measuring Tape, Paint (White or Silver) and a Yellow Lumber Crayon.

Rollers

There are three phases for rolling HMA for compaction, they are; the breakdown roller, which is the roller directly behind the HMA paver, the intermediate roller which is the roller that follows behind the breakdown roller and the finish roller is the last roller in the roller train.

The majority of compaction is achieved behind the breakdown roller but each roller does increase the percent compaction. The compaction test for ACP pavement will be done after the finish roller has completed that portion of rolling.

"Rice Density" Maximum Theoretical Density (Gmm)

The Rice Density test, WSDOT FOP for AASHTO T-209, is performed to determine the maximum specific gravity of an HMA product prior to placement on the roadway. After conversion to lbs./cu. Ft. (Kg/M^3),

$$\frac{\text{Nuclear Gauge Reading}}{\text{Rice Density}}*(100) = \%\text{compaction}$$

that value is used as a divisor in the equation to determine percentage of compaction. Please refer to the example on page 3-4.

Test Section for Compaction

Compaction Test Sections should be performed when requested by the Contractor at the beginning of a paving project. If the Contractor doesn't request a Compaction Test Section he should be strongly encouraged to do so. In any event if the Contractor chooses not to run a Compaction Test Section that fact needs to be documented in your "Inspectors Daily Report" as well as the Paving Inspectors IDR. Please refer to the example on page 3-5.

Washington State Department of Transportation

Rice Density

AASHTO T 209 - Flask Determination

Acc. # 12

Contract Number	SR Number	Project Engineer	Mix ID Number	Pit Number	Date
6611	18	CASE	41150	A-477	1/11/05

Section	Contractor	
MAPLE VALLEY TO ISSAQ/HOBART RD	ATKINSON/KLM	X English Units Metric Units

	Jar 1	Jar 2	Sample greater than 1500g.
A = Sample Mass (wt)	[1] 1515.2	[3]	grams
D = Mass (wt) - Pyncometer Jar, Water and Cover	2932.0		grams
E = Mass (wt) - Pycnometer Jar, Sample, Water and Cover	3826.4		grams
T - Water Temperature	74.1		°F
R - Temperature Correction Factor (From Table 2)	1.00040		
F = Rice Specific Gravity $\frac{A}{A+D-E} \times R$	[2] 2.442	[4]	

Note: When a constant temperature water bath is used to maintain the water temperature at 77F ± 1 (25° C ± 0.5) the temperature correction "R" should be 1. For all other water temperatures refer to table for the appropriate value for "R".

Rice Specific Gravity (Weighted Average)

$$\frac{([1] \times [2] + [3] \times [4])}{([1] + [3])} \quad \frac{([\_\_\_ \times \_\_\_] + [\_\_\_ \times \_\_\_])}{(\_\_\_ + \_\_\_)} = \_\_\_$$

Note: Calculate the Rice Specific Gravity "F" to 3 decimal places.

Rice Density (*English Units*)	F x 62.24 lb/ft³	____ x 62.24 lb/ft³ =	152.0 lb/ft³
Rice Density (*Metric Units*)	F x 997 kg/m³	____ x 997 kg/m³ =	____ kg/m³

Note: Calculate the Rice Density in Metric Units to the nearest whole number.
Calculate the Rice Density in English Units to the nearest 0.1lb/ft³.

Average Rice Density Determination

The average of the five (5) most recent Rice Densities from a given JMF should be used for compaction control.

If less than 5 Rice Densities are available, the averages will be based on the number of Rice Densities available, excluding mix design data. See test procedure for additional information.

	Test Date	Rice Density	
(1)	11-18	152.1	lb/ft³
(2)	11-18	152.4	lb/ft³
(3)	1-11	151.2	lb/ft³
(4)	1-11	152.0	lb/ft³
(5)			lb/ft³
	Running Average		lb/ft³

Note: Metric - Round to whole number. English - Round to 0.1 lb/ft³

Tested By	Date
K. Burns	1/11/05

DOT Form 350-157 EF
Revised 4/2002

Distribution: Copies to Project Engineer; Region Materials

Washington State
Department of Transportation

Asphalt Concrete Test Section Report

Indicate Unit of Measure: ◉ English ○ Metric

Date	Gauge
9/28/2005	32501

Project	Cont. No.
Maple Valley to Issaquah/Hobart Rd. I/C	6611
	SR No. 18

Standard Density Readings

No.		Readings	Average	Corrected
1.	0°	143.5	144.1	
	90°	144.7		
2.	0°	144.1	143.5	
	90°	142.9		
3.		143.8	143.8	
Sum			431.4	
Avg.			143.8	

Gauge Correction Factor 1.000

Remarks

Project Engineer: Derek Case		
Weather: Overcast	Air Temp From: 55 To: 80	
ACP: HMA Class 1/2"	ACB: N/A	Thickness: 0.25'
Wearing: N/A	Leveling: Yes	Class: HMA class 1/2"
Left: Yes	Right: N/A	Lane: ☐ NB ☐ SB ☐ EB ☒ WB
Other		

Rollers: Name, Type, and Mass
1. Dynapac CC-501 16 to 20 ton DDV
2. Sakai Pnuematic 14 ton
3. Hyster 350 DDS
4.

Rice 155.3 Std. Den. % of Rice 92.6

Stand. Density - Initial Pt. 92.6

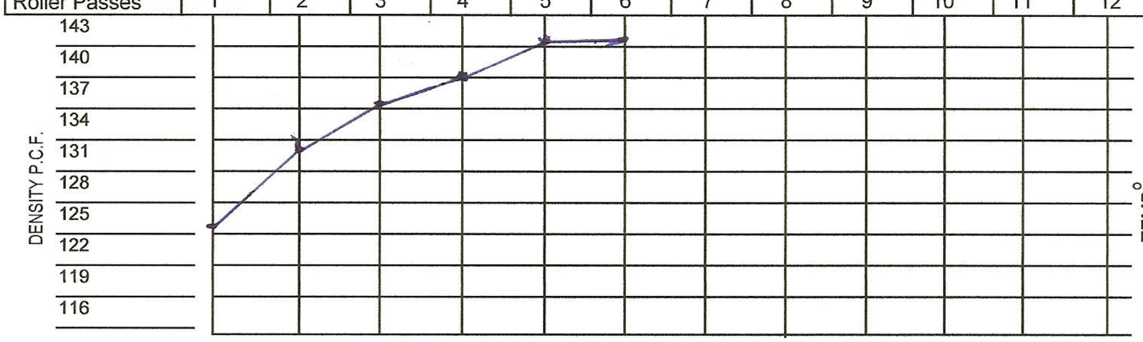
Insp. Diggler TD St. Insp. Meoff

Control Strip Approx. 267 Sq. Yards

Sta. 1490+55 Sta. 1488+50

1489+15 + 2 + 3 14 89+05 + 1 1488+90

Roller	1	1	2	2	2	3						
Gauge Reading	125.4	133.0	137.7	140.0	143.5	143.8						
Time (min. After Pavt. Laydown	3	7	11	15	19	21						
Temp.	290	275	250	225	200	190						
Roller Passes	1	2	3	4	5	6	7	8	9	10	11	12



*IP = Initial Point

Distribution: Region Materials

Project Engineer

DOT Form 350-073 EF
Revised 3/2002

Test Section Exercise

(Note: use page 3-7 as your worksheet)

Station 1+50 To Station 3+50
Paving Width: 12 feet
Paving Depth: 0.20’
Class ½” HMA Wearing
Right Lane Northbound
Rollers: (1) Dynapac Vibratory 11 ton, (2) Hyster 10 ton DDS, (3) Hyster 10 ton TS
RICE: 154.1
IP Station: 1 + 65

Pass	**Roller**	**Reading**	**Temperature**	**Time**
1	1	136.1	270	3 min
2	1	137.9	248	5 min.
3	1	138.6	234	10 min.
4	2	140.3	226	16 min.
5	2	142.5	208	20 min.
6	3	142.7	194	24 min.

Additional Readings 15 to 25 feet each side of I.P.
1 + 50 = 141.2/142.0 1 + 85 = 142.6/140.8
No gauge correction factor use 1.000

Washington State
Department of Transportation

Asphalt Concrete Test Section Report

Indicate Unit of Measure: ○ English ○ Metric

Standard Density Readings

No.		Readings	Average	Corrected
1.	0°			
	90°			
2.	0°			
	90°			
3.				
Sum				
Avg.				

Gauge Correction Factor ____________________

Remarks

____

____

____

____

____

Rice ____________ Std. Den. % of Rice ____________

Stand. Density - Initial Pt. ____________________

Insp. ________________ St. Insp. ________________

Date		Gauge	
Project		Cont. No.	
		SR No.	
Project Engineer			
Weather		Air Temp From:	To:
ACP	ACB	Thickness	
Wearing	Leveling	Class	
Left	Right	Lane ☐ NB ☐ SB ☐ EB ☐ WB	
Other			

Rollers: Name, Type, and Mass

1. ____________________
2. ____________________
3. ____________________
4. ____________________

Control Strip Approx. ____________

Sta. __________ Sta. __________

Roller												
Gauge Reading												
Time (min. After Pavt. Laydown												
Temp.												
Roller Passes	1	2	3	4	5	6	7	8	9	10	11	12

TEMP°

***IP = Initial Point**

Distribution: Region Materials ____________________

Project Engineer ____________________

DOT Form 350-073 EF
Revised 3/2002

Nuclear Gauge Correlation (SOP 730)

Gauge correlation is based on 10 cores and 10 complete density test determinations. Nuclear densities are taken the day of paving following the finish rolling. Cores are to be taken within 24 hours or sooner, if handling temperature can be achieved and must be taken prior to traffic running over areas that cores are to be taken. There is an example of a completed worksheet on page 3-9.

ACP CORE WORKSHEET

Field Office to Fill in All * Fields

0000315849

English or Metric

*Contract #: 6611	*Mix Class: 1/2" HMA	*Pit #: A-477	*Rice Density: 151.9	
*Field Inspector: J. Cooper	*Gauge #: 33043		*Gage Mode: Direct	
*Date Paved: 1-11-05	*Plan Lift Thickness: 0.35		*Cored For: Correlation or Density	

		1	2	3	4	5	6	7	8	9	10
	*Field Sample #:	1	2	3	4	5	6	7	8	9	10
	Dist. Mat. Lab. #:										
	*Station:	1420+00	1419+95	1419+90	1419+85	1419+80	1419+75	1419+70	1419+65	1419+60	1419+55
	*Offset	5' L									
A	Height	.37	.35	.33	.32	.34	.35	.34	.33	.35	.35
B	Sat. Surf. Dry Weight	1970.4	1837.0	1755.7	1690.5	1772.4	1814.3	1787.8	1726.4	1896.6	1879.0
C	Weight in Water	1117.1	1037.5	993.9	954.1	1001.1	1026.5	1007.9	962.5	1066.6	1062.8
D	Weight Difference (B - C)										
E	Dry Weight + Tare	2411.9	2276.4	2205.1	2133.3	2200.6	2267.9	2211.8	2151.7	2353.9	2329.4
F	Tare	459.2	458.8	467.1	462.9	448.2	474.7	446.8	456.4	480.3	469.2
G	Dry Weight (E - F)	1952.7	1817.6	1738.0	1670.4	1752.4	1793.2	1765.0	1695.3	1873.6	1860.2
H	Core Sp. Gr. (G / D)										
I	Core Density (H•N)										
	*Nuclear Gauge Density 1)	141.8	142.4	140.9	139.9	141.6	141.7	141.0	137.1	139.4	142.0
	2)	141.9	139.6	142.0	140.8	140.4	141.9	139.2	139.2	141.1	141.0
J	Average)	141.9 ✓	141.0 ✓	141.5 ✓	140.4 ✓	141.0 ✓	141.8 ✓	140.1 ✓	138.2 ✓	140.3 ✓	141.5 ✓
K	% of Max. Density (I / Rice Density)•100										
L	Density Ratio (I / J)										

M	Water Temp. 77° F Spec = 77±2°F / 25±1°C	Time 1	Weight	Time 2	Weight	Time 3	Weight	Time 4	Weight
N	Lbs. / Cu. Ft. of Water								

Cored By / Date: M. Rickert 1/11/05	Constant Weight Time in Oven: 3:45 Lab Use Only
Tested By / Date: M. Rickert 1/11/05	
Checked By / Date: [signature] 1-12-05	

Compaction Control Lot

A compaction control lot is a maximum of 400 tons of hot mix or less except for the last lot of the day which can be as large as 600 tons. Within the compaction control you have five (5) sub-lots. Each sub-lot is represented by one compaction test. For statistical analysis of the compaction control lot a minimum of five compaction tests are required.

Determining Lot Length

The lot length is denoted as "A" on the "Asphalt Concrete Pavement Compaction Report." The lot length is the length that a given amount of tons (tonnes) will cover for a certain width and depth of asphalt being placed.

English Units

Constant Factor: 2.05 tons per cubic yard

$$\frac{\text{Length x Width x Depth}}{27} \text{ x } 2.05 = \text{Tons per foot}$$

$$\frac{\text{Compaction Lot Size}}{\text{Tons per foot}} = \text{Lot Length "A"}$$

Example:
Width of Paving is 12 feet
Paving depth is 0.15
Compaction Lot Size is 400 tons

$$\frac{1' \text{ x } 12' \text{ x } 0.15' \text{ x } 2.05}{27} = 0.137 \text{ tons per foot}$$

$$\text{"A"} = \frac{400 \text{ tons}}{0.137 \text{ tons/ft}} = 2920 \text{ L.F. use } \mathbf{2900}$$

(When using English units, always round to the nearest 100 feet)

Y Values are selected so that lateral locations are no closer than 1.5 foot (0.45m) from the edge of a paving strip

SEQUENCE	X	Y	SEQUENCE	X	Y	SEQUENCE	X	Y	SEQUENCE	X	Y	SEQUENCE	X	Y
1	0.290	0.33	21	0.712	0.17	41	0.172	0.87	61	0.768	0.32	81	0.477	0.85
2	0.119	0.43	22	0.193	0.17	42	0.430	0.87	62	0.893	0.37	82	0.267	0.44
3	0.694	0.32	23	0.976	0.69	43	0.704	0.19	63	0.504	0.66	83	0.933	0.28
4	0.722	0.47	24	0.997	0.63	44	0.009	0.18	64	0.043	0.31	84	0.974	0.87
5	0.784	0.39	25	0.930	0.44	45	0.552	0.17	65	0.284	0.39	85	0.600	0.46
6	0.953	0.15	26	0.657	0.69	46	0.626	0.29	66	0.196	0.15	86	0.591	0.19
7	0.576	0.14	27	0.761	0.27	47	0.144	0.62	67	0.742	0.66	87	0.165	0.77
8	0.069	0.74	28	0.389	0.69	48	0.246	0.13	68	0.941	0.43	88	0.668	0.41
9	0.691	0.86	29	0.751	0.20	49	0.055	0.40	69	0.531	0.31	89	0.327	0.29
10	0.973	0.44	30	0.191	0.77	50	0.678	0.66	70	0.478	0.56	90	0.473	0.51
11	0.328	0.50	31	0.006	0.50	51	0.762	0.65	71	0.228	0.37	91	0.598	0.58
12	0.468	0.78	32	0.456	0.23	52	0.285	0.28	72	0.008	0.48	92	0.373	0.69
13	0.183	0.44	33	0.367	0.85	53	0.347	0.87	73	0.002	0.17	93	0.244	0.24
14	0.669	0.36	34	0.025	0.73	54	0.962	0.75	74	0.330	0.42	94	0.831	0.14
15	0.971	0.71	35	0.299	0.33	55	0.203	0.60	75	0.089	0.20	95	0.178	0.45
16	0.336	0.37	36	0.194	0.25	56	0.803	0.35	76	0.434	0.43	96	0.821	0.46
17	0.314	0.78	37	0.936	0.37	57	0.672	0.17	77	0.832	0.71	97	0.124	0.62
18	0.508	0.44	38	0.231	0.71	58	0.306	0.20	78	0.044	0.73	98	0.580	0.57
19	0.347	0.20	39	0.050	0.74	59	0.223	0.83	79	0.235	0.28	99	0.037	0.24
20	0.877	0.85	40	0.584	0.85	60	0.166	0.58	80	0.271	0.62	100	0.700	0.59

Washington State Department of Transportation

Asphalt Concrete Pavement Compaction Report

Date	Region	Project Engineer	SR Number	Section	Contract Number
1-11-05	Northwest	Derek Case	18	Maple Valley to I/H IK	6611

Class	Other	Wearing / Leveling / Base	Air Temperatures	Gauge Serial Number	Rice Density	Correlation Factor	Plan Depth (D)
☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G ☒ Other	HMA Cl. 1/2"	☐ Wearing ☒ Leveling ☐ Base	Start 45 End 50	32501	152.0	1.0027	0.15'

Beginning Station	Ending Station	Ahead/Back on Sta.	Lot Length (A)	Sublot Length [(A) x 0.2] = (L)	Width (W)	Lane	Direction	Lot # / Quantity	ACP Test Temp.
1479+00	1508+00	☒ Ahead on Sta. ☐ Back on Sta.	2900	580	12	☐ Lt. ☒ Rt.	☐ EB ☒ WB ☐ NB ☐ SB ☐ Other	1# 400	155°F

	Test Number	(X) Value Table (716)	Random Length (X) x (L)	+ Sublot (L) Increment	+/- Beg. Sta. = Test Sta.	(Y) Value Table (716)	Offset (Y) x (W)	Measured Depth	Core Density	Gauge Readings	Average Reading	Corrected Gauge	Percent of Rice
30	1	0.191	111	Zero	1480+11	0.77	9.2	0.16		137.5 138.3	137.9	138.3	91.0
31	2			(L)									
32	3			(L) x 2									
33	4			(L) x 3									
34	5			(L) x 4									

Beginning Station	Ending Station	Ahead/Back on Sta.	Lot Length (A)	Sublot Length [(A) x 0.2] = (L)	Width (W)	Lane	Direction	Lot # / Quantity	ACP Test Temp.
1508+00		☒ Ahead on Sta. ☐ Back on Sta.			12'	☐ Lt. ☒ Rt.	☐ EB ☒ WB ☐ NB ☐ SB ☐ Other	2# 300	155°F

Test Number	(X) Value Table (716)	Random Length (X) x (L)	+ Sublot (L) Increment	+/- Beg. Sta. = Test Sta.	(Y) Value Table (716)	Offset (Y) x (W)	Measured Depth	Core Density	Gauge Readings	Average Reading	Corrected Gauge	Percent of Rice
1	0.347		Zero		0.87							
2			(L)									
3			(L) x 2									
4			(L) x 3									
5			(L) x 4									

Remarks
Depth on Lot #2 0.20'

Standard Count Lot #2 = 2453

Rollers	DDV	P	TS
Passes	3	2	3

Roller Codes:
SDV - Single Drum Vibrator
DDV - Double Drum Vibrator
P - Pneumatic
TS - Tandem Steel

Gauge Operator	Date	Street Inspector	Date	Contractor	Date

DOT Form 350-092 EF
Revised 3/2002

Distribution: Original - Project Engineer; Copies To: Contractor; Region Materials

Random Number

Practice Exercise

The contractor is going to pave a 12 foot wide strip of HMA Class ½” for wearing course, 0.20 feet depth, right of centerline of the WS line. Quantity in this pay lot is 300 tons. The Standard count from the nuclear gauge is 2453. The beginning station is 1508+00 and the paving is moving ahead on station. Determine the test station and offset using the information given to fill in the A.C.P. (H.M.A.) Compaction Report on page **3-12**.

Practice Exercise

Using the worksheet you used to determine test locations, determine the percent of RICE using the following gauge readings.

English Units

1.) 137.4/138.2;
2.) 141.2/142.6;
3.) 137.1/137.9;
4.) 139.0/140.0;
5.) 137.0/137.0

Recommended Procedure for Using the Nuclear Gauge

Use direct transmission, whenever asphalt depth is 0.11 feet or greater. Thin lift density gauges are acceptable alternates, preferred use over -backscatter with underlying densities. Backscatter mode last choice. Requires advance determination of underlying density at specific test locations to use for specification testing.

This method is not allowed for WSDOT projects. Density test locations within a compaction lot should avoid mat edges and "end transition zones" at bridge ends or transverse (night) joints. The lateral spacing is accommodated in the updated random number table. By common agreement, we will stay at least 25 feet away from the end joints. To handle this, whenever the random number fall sin the 25 foot area, move ahead (or back) on stationing by 25 feet to get the corrected test location.